DRAFT RECOMMENDATION

TC 8/SC 8 (NL)

Combined revision of R 6, R 31 and R 32

Gas meters

Part 1: Requirements

Draft submitted for CIML postal ballot on 2006.03.30.

Voting closes on 2006.06.30.

Draft Revision R 6, R 31 and R 32

ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE

INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY

Contents

Foreword

The International Organization of Legal Metrology (OIML) is a worldwide, intergovernmental organization whose primary aim is to harmonize the regulations and metrological controls applied by the national metrological services, or related organizations, of its Member States.

The two main categories of OIML publications are:

- International Recommendations (OIML R), which are model regulations that establish the metrological characteristics required of certain measuring instruments and which specify methods and equipment for checking their conformity; the OIML Member States shall implement these Recommendations to the greatest possible extent;
- International Documents (OIML D), which are informative in nature and intended to improve the work of the metrological services.

OIML Draft Recommendations and Documents are developed by technical committees or subcommittees, which are formed by the Member States. Certain international and regional institutions also participate on a consultation basis.

Cooperative agreements are established between OIML and certain institutions, such as ISO and IEC, with the objective of avoiding contradictory requirements; consequently, manufacturers and users of measuring instruments, test laboratories, etc. may apply simultaneously OIML publications and those of other institutions.

International Recommendations and International Documents are published in French (F) and English (E) and are subject to periodic revision.

This publication - reference OIML R xxx, edition xxxx (E) – was developed by the OIML Technical Subcommittee TC8/SC8 Gas meters. It was approved for final publication by the International Committee of Legal Metrology in xxxx and will be submitted to the International Conference of Legal Metrology in yyyy for formal sanction. It supersedes the previous editions OIML R 6 (1989), R 31 (1995) and R 32 (1989).

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Explanatory note (will be deleted from the final text of the Recommendation)

The last decade has shown rapid technological developments in the field of gas metering. Compared to the existing diaphragm, rotary piston and turbine gas meters a range of new metering technologies has been developed. Ultrasonic meters and coriolis meters are now used for custody transfer purposes, the latter measuring gas quantities in mass units. New metering principles are being developed that have potential for custody transfer measurements. Recently, manufacturers have begun to develop compact equipment to measure gas in energy units. The latest development is the miniaturization of electronic components, the integration of electronics in mechanical gas meters and the addition of more functionality in electronic gas meters.

Apart from technological developments, gas markets are liberalized in some countries. As a result trade and transport responsibilities are separated into different companies. Gas transportation and gas distribution companies will not own the gas and only receive a fee for transporting the gas to the end user. As a result the gas balance of these companies will gain more attention, requiring more accurate gas meters. As there are different gas compositions with different superior calorific values there is a tendency to bill the supplied gas on an energy basis.

The above mentioned technical and economical developments have been the start for upgrading the existing OIML Recommendations R6 (1989), R31 (1995) and R32 (1989) into this new OIML Recommendation. The increasing pace of product developments requires a robust Recommendation that can cope with these developments without the necessity of being modified in short intervals. This is expressed in the philosophy behind the document:

- Focus on metrological performance rather than technical requirements.
- Requirements independent of gas metering technology.
- Metering also in mass and energy units.
- Metering of both fuel gases and industrial gases (and also supercritical ethylene).
- Addition of a new meter class (class 0,5).
- Requirements scalable with the meter properties.

As a result the requirements in this document are less detailed than in the previous Recommendations.

Preface to the Final Committee Draft

This final committee draft of this Recommendation is the result of an extensive discussion with experts participating in TC8/SC8. The first CD was discussed at a meeting in Dordrecht, October 2004. The second CD was discussed in Delft, June 2005. The resolutions of both meetings as well as most of the comments that were made to 1CD and 2CD were implemented in the third CD.
On 20 September 2005 the secretariats of TC8/SC7 and TC8/SC8 met in Paris with the BIML. Objective of the meeting was to solve the overlap between the draft recommendations of both secretariats. The results of this meeting were laid down in OIML Information Letter No. 9 (7 November 2005) and were communicated to all CIML members by the BIML. The secretariat informed the experts participating to TC8/SC8 committee.
A new working item on gas metering will be proposed to the CIML meeting of October 2006. This work item aims to integrate the (draft) recommendations of the two secretariats in one document, which will solve the discrepancies between the documents.
As a result 3CD was limited to gas meters only, the requirements and references to conversion were removed.
The 3CD gas meters was approved by the 22 P-members of TC8/SC8 with 19 votes for the document, 1 against and 1 abstain.
The comments were implemented in this Final Committee Draft will be distributed by BIML as DR for voting and comments among CIML members.

Although the present Final Committee Draft is marked as Part 1: Requirements, the required tests and the corresponding requirements are already mentioned in this draft. It is intended to repeat the present chapter 7 and Annexes A, B and C in Part 2: Test Methods. Part 3 will made after Part 2 is ready.

BIML note: During the editorial review of the final Committee Draft – besides numerous editorial corrections and modifications - the term Accuracy Class (used in the text) - was additionally introduced in Clause 2 Terminology.

GAS METERS
PART 1: REQUIREMENTS

1. Scope

This document applies to gas meters based on any principle, used to meter the quantity of gas in volume, mass or energy units that has passed the meter at operating conditions. It applies also to gas meters intended to measure quantities of gaseous fuels or other gases, except gases in the liquefied state and steam.

Dispensers for compressed natural gas (CNG dispensers) are also excluded from the scope of this Recommendation.

The document also applies to correction, other ancillary and electronic devices that can be attached to the gas meter. However, provisions for conversion devices, either as part of the gas meter or as a separate instrument, or provisions for devices for the determination of the superior calorific value and gas metering systems consisting of several components are defined in the draft OIML Recommendation on Measurement systems for gaseous fuel [9].

2. Terminology

The terminology used in this Recommendation conforms to the International Vocabulary of Basic and General Terms in Metrology (VIM - Edition 1993) [1] and the International Vocabulary of Terms in Legal Metrology (VML – Edition 2000) [2]. In addition, for the purposes of this Recommendation, the following definitions apply.

2.1. GAS METER AND ITS CONSTITUENTS

2.1.1. Gas meter

An instrument intended to measure, memorize and display the quantity of gas passing the flow sensor at operating conditions.

2.1.2. Measurand (VIM 2.6)

Particular quantity subject to measurement.

2.1.3. Sensor (VIM 4.14)

Element of a measuring instrument or measuring chain that is directly affected by the measurand.

2.1.4. Measuring transducer (VIM 4.3)

A device that provides an output quantity having a determined relationship to the input quantity.

2.1.5. Mechanical output constant (mechanical gas meters only)

The value of the quantity corresponding to one complete revolution of the shaft of the mechanical output; this value is determined by multiplying the value of the quantity corresponding to one complete revolution of the test element by the transmission ratio of the indicating device to this shaft. The mechanical output is an element to drive an ancillary device.

2.1.6. Calculator

A part of the gas meter, which receives the output signals from the measuring transducer(s) and, possibly, associated measuring instruments, transforms them and, if appropriate, stores the results in memory until they are used. In addition, the calculator may be capable of communicating both ways with ancillary devices.

2.1.7. Indicating device (VIM 4.12 adapted)

A part of the gas meter, which displays the measurement results, either continuously or on demand.

Note: A printing device, which provides an indication at the end of the measurement, is not an indicating device.

2.1.8. Adjustment device

A device incorporated in the gas meter that only allows the error curve to be shifted generally parallel to itself, with a view to bringing errors (of indication) within the maximum permissible errors.

2.1.9. Correction device

A device intended for correction of known errors as a function of e.g. flowrate, Reynolds number (curve linearization), or pressure and/or temperature.

2.1.10. Ancillary device

A device intended to perform a particular function, directly involved in elaborating, transmitting or displaying measurement results.

The main ancillary devices are:

a) repeating indicating device;
b) printing device;
c) memory device;
d) communication device.

Note 1: An ancillary device is not necessarily subject to metrological control.

Note 2: An ancillary device may be integrated in the gas meter.

2.1.11. Associated measuring instrument

An instrument connected to the calculator or the correction device, for measuring certain gas properties, for the purpose of making a correction.

2.1.12. Equipment under test (EUT)

The (part of the) gas meter and / or associated devices, which are exposed to one of the tests.

2.1.13. Family of meters

A family of meters is a group of meters of different sizes and/or different flowrates, in which all the meters shall have the following characteristics:

- the same manufacturer
- geometric similarity of the measuring part
- the same metering principle
- roughly the same ratios Q_{max}/Q_{min} and Q_{max}/Q_t
- the same accuracy class
- the same electronic device for each meter size
- a similar standard of design and component assembly
- the same materials for those components that are critical to the performance of the meter

2.2. METROLOGICAL CHARACTERISTICS

2.2.1. Quantity of gas

Total quantity of gas, obtained by integrating the flow over time, expressed as volume V, mass m or energy E passed through the gas meter, disregarding the time taken. This is the measurand.

2.2.2. Indicated value (of a quantity)

Value Y_i of a quantity, as indicated by the meter.

2.2.3. Cyclic volume of a gas meter (positive displacement gas meters only)

The volume of gas corresponding to one full revolution of the meter interior (working cycle).

2.2.4. True value (of a quantity) (VIM 1.19 + notes)

Value consistent with the definition of a given particular quantity.

2.2.5. Conventional true value (of a quantity) (VIM 1.20)

Value Y_{ref} attributed to a particular quantity and accepted, sometimes by convention, as having an uncertainty appropriate for a given purpose.

2.2.6. Absolute error (of indication) (VIM 3.10 + notes)

Indicated value of a quantity Y_i minus a true value of a quantity.

2.2.7. Relative error or error (of indication) e (VIM 3.12 + note)

Error of measurement divided by a true value of the measurand.

The error is expressed as a percentage, and is calculated by:

$$e = \frac{(Y_i - Y_{ref})}{Y_{ref}} \times 100 \ \%$$

2.2.8. Weighted mean error (WME)

The weighted mean error (WME) is calculated as follows:

$$WME = \frac{\sum_{i=1}^{n}\left((Q_i / Q_{\max}) \cdot e_i\right)}{\sum_{i=1}^{n}\left(Q_i / Q_{\max}\right)}$$

where:

- Q_i/Q_{max} is a weighting factor.
- e_i is the error at the flowrate Q_i.
- at $Q_i > 0{,}9 \cdot Q_{max}$ a weighting factor of 0,4 shall be used instead of 1.

2.2.9. Intrinsic error

The error determined under reference conditions.

2.2.10. Error shift or Fault Δe (D11, 3.9)

The difference between the error of indication and the intrinsic error of a measuring system or of its constituent elements.

Note: In practice this is the difference between the error of the meter observed during or after a test, and the error of the meter prior to this test, performed under reference conditions.

2.2.11. Maximum permissible error (MPE) (VIM 5.21)

The extreme values permitted by the present Recommendation for an error.

2.2.12. Accuracy class (VIM 5.19)

Class of measuring instruments that meet certain metrological requirements that are intended to keep errors within specified limits.

2.2.13. Durability (D11, 3.17)

Ability of a measuring instrument to maintain its performance characteristics over a period of use.

2.2.14. Operating conditions

The conditions of the gas (temperature, pressure and gas composition) at which the quantity of gas is measured.

2.2.15. Rated operating conditions (adapted from VIM 5.5)

Conditions of use giving the range of values of the measurand and the influence quantities, for which the errors of the gas meter are required to be within the maximum permissible errors.

2.2.16. Reference conditions (adapted from VIM 5.7)

A set of reference values, or reference ranges of influence quantities, prescribed for testing the performance of a gas meter, or for the intercomparison of the results of measurements.

2.2.17. Base conditions

The conditions to which the measured volume of gas is converted (examples: base temperature and base pressure).

Note: Operating and base conditions relate to the volume of gas to be measured or indicated only and should not be confused with "rated operating conditions" and "reference conditions" (VIM 5.05 and 5.07) which refer to influence quantities.

2.2.18. Test element of an indicating device

A device to enable precise reading of the measured gas quantity.

2.2.19. Resolution (of an indicating device) (VIM 5.12)

The smallest difference between indications of an indicating device that can be meaningfully distinguished.

Note: For a digital device, this is the change in the indication when the least significant digit changes by one step. For an analogue device, this is half the difference between subsequent scale marks.

2.2.20. Drift (VIM 5.16)

Slow change of a metrological characteristic of a measuring instrument.

2.3. OPERATING CONDITIONS

2.3.1. Flowrate, Q

Quotient of the actual quantity of gas passing through the gas meter and the time taken for this quantity to pass through the gas meter.

2.3.2. Maximum flowrate Q_{max}

The highest flowrate, at which a gas meter is required to operate, within its maximum permissible error, whilst operated within its rated operating conditions.

2.3.3. Minimum flowrate, Q_{min}

The lowest flowrate, at which a gas meter is required to operate within the maximum permissible error, whilst operated within its rated operating conditions.

2.3.4. Transitional flowrate Q_t

Flow rate, which occurs between the maximum flowrate Q_{max}, and the minimum flowrate Q_{min}, that divides the flowrate range into two zones, the "upper zone" and the "lower zone", each characterized by its own maximum permissible error.

2.3.5. Working temperature, t_w

The temperature of the gas to be measured at the gas meter.

2.3.6. Minimum and maximum working temperature, t_{min} and t_{max}

The minimum and maximum gas temperature that a gas meter can withstand, within its rated operating conditions, without deterioration of its metrological performance.

2.3.7. Working pressure, p_w

The gauge pressure of the gas to be measured at the gas meter. The gauge pressure is the difference between the absolute pressure of the gas and the atmospheric pressure.

2.3.8. Minimum and maximum working pressure, p_{min} and p_{max}

The minimum and maximum internal gauge pressure that a gas meter can withstand, within its rated operating conditions, without deterioration of its metrological performance.

2.3.9. Static pressure loss or pressure differential, Δp

The mean difference between the pressures at the inlet and outlet of the gas meter while the gas is flowing.

2.3.10. Working density, ρ_w

The density of the gas flowing through the gas meter, corresponding to p_w and t_w

2.4. TEST CONDITIONS

2.4.1. Influence quantity (VIM 2.7)

A quantity that is not the measurand but which affects the result of the measurement.

2.4.2. Influence factor (D11, 3.13.1)

An influence quantity having a value within the rated operating conditions of the gas meter, as specified in this Recommendation.

2.4.3. Disturbance (D11, 3.13.2)

An influence quantity having a value within the limits specified in this Recommendation, but outside the specified rated operating conditions of the gas meter.

Note: An influence quantity is a disturbance if for that influence quantity the rated operating conditions are not specified.

2.4.4. Overload conditions

The extreme conditions, including flowrate, temperature, pressure, humidity and electromagnetic interference that a gas meter is required to withstand without damage. When it is subsequently operated within its rated operating conditions, it must do so within its maximum permissible error.

2.4.5. Test

A series of operations intended to verify the compliance of the equipment under test (EUT) with certain requirements.

2.4.6. Test procedure

A detailed description of the test operations.

2.4.7. Test program

A description of a series of tests for a certain type of equipment.

2.4.8. Performance test

A test intended to verify whether the equipment under test (EUT) is capable of accomplishing its intended functions.

2.5. ELECTRONIC EQUIPMENT

2.5.1. Electronic gas meter

A gas meter equipped with electronic devices.

Note: For the purposes of these requirements auxiliary equipment, as far as it is subject to metrological control, is considered part of the gas meter, unless the auxiliary equipment is approved and verified separately.

2.5.2. Electronic device

A device employing electronic sub-assemblies and performing a specific function. Electronic devices are usually manufactured as separate units and are capable of being tested independently.

2.5.3. Electronic sub-assembly

A part of an electronic device, employing electronic components and having a recognizable function of its own.

2.5.4. Electronic component

The smallest physical entity, which uses electron or gap conduction in semi-conductors, or conduction by means of electrons or ions in gases or in a vacuum.

3. Constructional requirements

3.1. CONSTRUCTION

3.1.1. Materials

A gas meter shall be made of such materials and be so constructed to withstand the physical, chemical and thermal conditions to which they are likely to be subjected and to fulfil correctly their intended purposes throughout their life.

3.1.2. Soundness of cases

The case of a gas meter shall be gas-tight up to the maximum working pressure of the gas meter. If meters are to be installed in the open air they shall be impermeable to runoff water.

3.1.3. Condensation / climate provisions

The manufacturer may incorporate devices for the reduction of condensation, where condensation may adversely affect the performance of the device.

3.1.4. Protection against external interference

A gas meter shall be constructed and installed in such a way that mechanical interference capable of affecting the meter's accuracy is either prevented or results in permanently visible damage to the gas meter or to the verification marks or protection marks.

3.1.5. Indicating device

The indicating device can be connected to the meter body physically or remotely. In the latter case the data to be displayed shall be stored in the gas meter.

Note: National authorities may make provisions to guarantee access to the data stored in the meter for customers and consumers.

3.1.6. Safety device

The gas meter may be equipped with a safety device that shuts off the gas flow in case of calamities, like earthquakes or fire. A safety device may be connected to the gas meter, provided that they do not influence the metrological integrity.

Note: A mechanical gas meter equipped with an earthquake sensor plus electrical powered valve is not considered to be an electronic gas meter.

3.1.7. Connections between electronic parts

Connections between electronic parts shall be reliable and durable.

3.1.8. Components

Components of the meter may be exchanged without subsequent verification only, if the type examination establishes that the metrological properties and especially the accuracy of the meter are not influenced by the exchange of the components concerned. Such components shall be identified with at least their own type indication.

Note: National bodies may require components to be marked with the model(s) of the meter(s) to which they may be attached and may require such exchange to be carried out by authorized persons.

3.1.9. Zero flow

The gas meter totalization shall not change when the flowrate is zero, while the installation conditions are free of pulsations and vibrations.

Note: This requirement refers to stationary operating conditions. This condition does not refer to the response of the gas meter to changed flowrates.

3.2. FLOW DIRECTION

3.2.1. Direction of the gas flow

On a gas meter where the indicating device registers positively for only one direction of the gas flow, this direction shall be indicated by some other clearly understood method, e.g. an arrow. This indication is not required if the direction of the gas flow is determined by the construction.

3.2.2. Plus and minus sign

The manufacturer shall specify whether or not the gas meter is designed to measure bi-directional flow.

In case of bi-directional flow a double-headed arrow with a plus and minus sign shall be used to indicate which flow direction is regarded as positive and negative respectively.

3.2.3. Recording of bi-directional flow
If a meter is designed for bi-directional use, the quantity of gas passed during reverse flow shall either be subtracted from the indicated quantity or be recorded separately. The maximum permissible error shall be met for both forward and reverse flow.

3.2.4. Reverse flow
If a meter is not designed to measure reverse flow, the meter shall either prevent reverse flow, or it shall withstand incidental or accidental reverse flow without deterioration or change in its metrological properties.

3.2.5. Indicating device
A gas meter may be provided with a device to prevent the indicating device from functioning whenever gas is flowing in an unauthorised direction.

3.3. PRESSURE TAPPINGS

3.3.1. General
If a gas meter is designed to operate above an absolute pressure of 0,15 MPa(a), the manufacturer shall either equip the meter with pressure tappings, or specify the position of pressure tappings in the installation pipe work.

3.3.2. Bore
The bore of the pressure tappings shall be large enough to allow correct pressure measurements.

3.3.3. Closure
Pressure tappings shall be provided with a means of closure to make them gas-tight.

3.3.4. Markings
The pressure tapping on the gas meter for measuring the working pressure (2.3.7) shall be clearly and indelibly marked "p_m" (i.e. the pressure measurement point) or "p_r" (i.e. the pressure reference point) and other pressure tappings "p".

3.4. INSTALLATION CONDITIONS

The manufacturer shall specify the installation conditions (insofar applicable) with respect to:
- the position to measure the working temperature of the gas (2.3.5);
- filtering;
- levelling and orientation;
- flow disturbances;
- pulsations or acoustic interference;
- rapid pressure changes;
- free of mechanical stress (due to torque and bending);
- mutual influences between gas meters;
- mounting instructions;
- maximum allowable diameter differences between gas meter and connecting pipe work;
- other relevant installation conditions.

4. Seals and markings

4.1. MEASUREMENT UNITS

All quantities shall be expressed in SI units [3],[4] or other legal units of measurement [5], unless a country's legal units are different.
In the next section the unit corresponding to the quantity indicated is expressed by <unit>.

4.2. MARKINGS AND INSCRIPTIONS

Insofar as relevant, the following information shall be presented on the casing or on an identification plate, or viewed clearly and unambiguously via the indicating device:

a) Type approval mark (according to national or regional regulation);

b) Name or trade mark of the manufacturer;

c) Type designation;

d) The serial number of the gas meter and its year of manufacture;

e) Accuracy class;

f) The maximum flowrate Q_{max} = … <unit>;

g) The minimum flowrate Q_{min} = … <unit>;

h) The transition flowrate Q_t = … <unit>;

i) The gas temperature range and gas pressure range for which the errors of the gas meter are required to be within the maximum permissible errors, expressed as:
$t_{min} – t_{max}$ = … - … <unit>
$p_{min} – p_{max}$ = … - … <unit> gauge pressure;

j) The density range in which the errors are required to comply with the maximum permissible errors may be indicated, and shall be expressed as:
ρ = … - … <unit>
This marking may replace the range of working pressures (i) unless the working pressure marking refers to a built-in conversion device;

k) The pulse values of HF and LF frequency outputs (imp/<unit>, pulse/<unit>, <unit>/imp);

Note: The pulse value is presented with at least six significant figures, unless it is equal to an integer multiple or decimal fraction of the used unit.

l) Letter V or H, as applicable, if the meter can only be operated in the vertical or horizontal position;

m) An indication of the flow direction, e.g. an arrow (if applicable, see 3.2.1 and 3.2.2);

n) The measurement point for the working pressure according to 3.3.4;

o) The environmental temperatures if they differ from the gas temperature as mentioned in i);

p) Software: firmware version.

For mechanical gas meters with a built-in mechanical conversion device having only one indicating device, the following additional inscription shall be applied:

q) The base temperature t_b = … <unit>;

r) The temperature t_{sp} = … <unit> as specified by the manufacturer according to 5.3.4.

For meters with output drive shafts the following additional information shall be provided:

s) Gas meters fitted with output drive shafts or other facilities for operating detachable additional devices shall have each drive shaft or other facility characterised by an indication of its constant (C) in the form "1 rev = … <unit>" and the direction of rotation. "rev" is the abbreviation of the word revolution;

t) If there is only one drive shaft the maximum permissible torque shall be marked in the form "M_{max} = … N.mm";

u) If there are several drive shafts, each shaft shall be characterised by the letter M with subscript in the form "M_1, M_2, … M_n";

v) The following formula shall appear on the gas meter, preferably on the data plate:

$$k_1M_1 + k_2M_2 + \ldots + k_nM_n \leq \text{A} \ \text{N.mm},$$

where:
A: is the numerical value of the maximum permissible torque applied to the drive shaft with the highest constant, where the torque is applied only to this shaft; this shaft shall be characterised by the symbol M_1,
k_i (i = 1, 2, … n): is a numerical value determined as follows: $k_i = C_1 / C_i$,
M_i (i = 1, 2, … n): represents the torque applied to the drive shaft characterised by the symbol M_i,
C_i (i = 1, 2, … n): represents the constant for the drive shaft characterised by the symbol M_i.

For gas meters with electronic devices, the following additional information shall be provided where appropriate:

w) For an external power supply: the nominal voltage and nominal frequency;

x) For a non-replaceable or replaceable battery: the latest date that the battery is to be replaced or the remaining battery capacity.

4.2.1. Visibility
These markings shall be visible, easily legible and indelible under rated conditions of use.
The use of any marking other than those prescribed in the type approval document shall not lead to confusion.

4.3. VERIFICATION MARKS AND PROTECTION DEVICES

4.3.1. General provision

Protection of the metrological properties of the meter is done via hardware (mechanical) sealing or via electronic sealing devices.

In any case memorised quantities of gas shall be protected by means of a hardware seal.

The design of verification marks and hardware seals is subject to national legislation. Seals shall be able to withstand outdoor conditions.

4.3.2. Verification marks

Verification marks indicated that the gas meter has successfully passed the initial verification (7.5). Verification marks shall be realized as hardware seals.

4.3.3. Hardware sealing
In case of hardware sealing the location of the marks shall be chosen in such a way that the dismantling of the part sealed by one of these marks results in permanently visible damage to this seal.
Locations to be sealed with verification or protection marks shall be provided on the instrument:

a) On all plates which bear information prescribed by this Recommendation;
Note This requirement is only necessary if the nameplate can be detached from the meter.

b) On all parts of the case which cannot be otherwise protected against interference likely to affect the accuracy of the measurement.

4.3.4. Electronic sealing devices

4.3.4.1. When access to parameters that participate in the determination of results of measurement needs to be protected, but is not protected by mechanical seals, the protection shall fulfil the following provisions:

a) Access shall only be allowed to authorized people, for example by means of a code (password) or of a special device (hard key, etc.) and, after changing parameters, the instrument may be put into use "in sealed condition" again without any restriction,
or
Access is allowed without restrictions but, after changing parameters, the instrument shall only be put into use "in sealed condition" again by authorized persons, e.g. by using a "password" (similar with classical sealing).

b) The code (password) shall be changeable.

c) The device shall either clearly indicate when it is in the configuration mode (not under legal metrological control), or it shall not operate while in this mode. This status shall remain until the instrument has been put into use “in sealed condition” in accordance with clause (a).

d) Identification data concerning the latest intervention shall be recorded into an event logger. The record shall include at least:
   - an identification of the authorized person that implemented the intervention
   - the date and time of the intervention

Beside the above mentioned items it is also recommended to store the following items:
- an event counter
- the old value of the changed parameter
- totals of the registers
- an identification of the accredited person, that implemented the intervention

The traceability of the last intervention shall be assured. If it is possible to store more than one intervention, and if deletion of a previous intervention must occur to permit a new record, the oldest record shall be deleted.

4.3.4.2. For instruments with parts which may be disconnected one from another, whether these are interchangeable or not, the following provisions shall be fulfilled:

a) It shall not be possible to access parameters that participate in the determination of results of measurements through disconnected points unless the provisions in clause 4.3.4.1 are fulfilled;

b) Interposing any device which may influence the accuracy shall be prevented by means of electronic and data processing securities or, if not possible, by mechanical means.

c) Moreover, these instruments shall be provided with devices which do not allow them to operate if the various parts are not configured according to the manufacturer’s specification.

Note: Disconnections which are not allowed to the user may be prevented, for example by means of a device that prevents any measurement after disconnecting and reconnecting.

5. Metrological requirements

5.1. RATED OPERATING CONDITIONS

The rated operating conditions for a gas meter shall be as follows:

Flowrate range:	Q_{min} to Q_{max} inclusive
Ambient temperature range:	lower temperature to be chosen from –40 °C, –25 °C, –10 °C and +5 °C upper temperature to be chosen from +30 °C, +40 °C, +55 °C and +70°C
Ambient humidity range:	≤93 %
Working pressure range:	p_{min} to p_{max} inclusive
Gases:	the family of natural gases, industrial gases or supercritical gases, to be specified by the manufacturer

Note *Supercritical refers to the situation where there is no distinction between the gaseous and liquefied state of the fluid.*

5.2. VALUES OF Q_{MAX}, Q_T AND Q_{MIN}

The flowrate characteristics of a gas meter shall be defined by the values of Q_{max}, Q_t and Q_{min} as stated in Table 1.

Table 1 — Flowrate characteristics

Q_{max} / Q_{min}	Q_{max} / Q_t
≥ 50	≥ 10
≥ 5 and < 50	≥ 5

5.3. ACCURACY CLASSES AND MAXIMUM PERMISSIBLE ERRORS

5.3.1. General

Gas meters shall be designed and manufactured such that their errors do not exceed the applicable maximum permissible errors under rated operating conditions, listed in section 5.3.3.

5.3.2. Correction for known errors

Gas meters may be equipped with a correction device, which can be used to bring errors as close as possible to zero. A correction device can be used to improve the class specification.
The correction device shall not be used for the correction of a pre-estimated drift.

5.3.3. Accuracy classes and maximum permissible errors (MPE)

Gas meters shall be classified into Accuracy Classes given in Table 2.

The errors shall be within the applicable values given in Table 2.

Table 2 — Maximum permissible errors of gas meters in ±.

Flowrate Q	On type approval and initial verification Accuracy Class			In-service * Accuracy Class		
	0,5	1	1,5	0,5	1	1,5
$Q_{min} \leq Q < Q_t$	1 %	2 %	3 %	2 %	4 %	6 %
$Q_t \leq Q \leq Q_{max}$	0,5 %	1 %	1,5 %	1 %	2 %	3 %

*Notes: *) National Authorities may decide whether they will implement in-service maximum permissible errors or not.*

5.3.4. A mechanical gas meter with a built-in mechanical temperature conversion device

For a mechanical gas meter with a built-in mechanical temperature conversion device having only one indicating device displaying the volume at base conditions, the maximum permissible errors as indicated in Table 2 are increased by 0,5 % in a range of 30 °C extending symmetrically around the temperature t_{sp} specified by the manufacturer. Outside this range an additional increase of 0,5 % is permitted in each interval of 10 °C.

Compliance with these requirements shall be verified at temperatures deviating not more than 2 °C from the upper and lower limits of the specified intervals.

5.4. WEIGHTED MEAN ERROR (WME)

The weighted mean error (WME) shall be within the maximum permissible values given in Table 3.

Table 3 — Maximum permissible weighted mean error in ±.

Flowrate Q	On type approval and initial verification Accuracy Class			In-service Accuracy Class		
	0,5	1	1,5	0,5	1	1,5
WME	0,2 %	0,4 %	0,6%	--	--	--

5.5. REPAIR AND DAMAGE OF SEALS

After repair or damage of the seals the maximum permissible errors on type approval and initial verification as stated in Table 2 are applicable, as well as the maximum permissible weighted mean error as stated in Table 3.

6. Technical requirements

6.1. INDICATING DEVICE

6.1.1. General provisions

The indicating device associated with the gas meter shall indicate the quantity of gas measured - volume, mass or energy - in the corresponding units. The reading shall be clear and unambiguous.

The indicating device may be:

a) a mechanical indicating device as described in point 6.1.4.

b) an electromechanical or electronic indicating device as described in point 6.1.5.

c) a combination of a) and b).

Indicating devices shall be non-resetable and shall be non-volatile (i.e. be able to show the last stored indication after the device has recovered from an intervening power failure).

Where the indicating device shows decimal submultiples of the quantity measured, these submultiples shall be separated by a clear decimal sign from those showing units.

It may be possible to use one display for other indications as well, as long as it is clear which quantity being displayed.

6.1.2. Indicating range

The indicating device shall be able to record and display the indicated quantity of gas corresponding to at least 1000 hours of operation at the maximum flowrate Q_{max}, without returning to the original reading.

6.1.3. Resolution

The least significant digit shall not exceed the quantity of gas passed during one hour at Q_{min}.

Where the least significant digit (last drum) shows a decimal multiple of the quantity measured, the faceplate or electronic display shall bear:

a) either one (or two, or three, etc.) fixed zero(s) after the last drum or digit

b) or the marking : " x 10 " (or " x 100 ", or " x 1 000 ", etc.)

so that the reading is always in the units mentioned in section 4.1.

6.1.4. Mechanical indicating device

A mechanical indicating device shall consist of drums; the last element (i.e. the one with the smallest scale interval) may however be an exception to this rule.

The minimum height of the numerals shall be 4,0 mm and the minimum width shall be 2,4 mm.

The advance by one unit of a figure of any order shall take place completely while the figure of an order immediately below passes through the last tenth of its course.

6.1.5. Electromechanical or electronic indicating device

The continuous display of the quantity of gas during the period of measurement is not mandatory.

The electronic indicating device shall be provided with a display test.

6.1.6. Remote indicating device

In the case where an indicating device is used remotely, the identification of the associated gas meter shall be clear.
The integrity of the communication between the instrument and the indicating device shall be checked.

Note: The serial number of the associated gas meter can be used for a clear identification.

6.2. TEST ELEMENT

6.2.1. General

Gas meters shall be designed and constructed incorporating

a) an integral test element, or
b) a pulse generator, or
c) arrangements permitting the connection of a portable test unit.

6.2.2. Integral test element

The integral test element may consist of the last element of the mechanical indicating device in one of the following forms:

a) a continuously moving drum bearing a scale, where each subdivision on the drum is regarded as an increment of the test element;
b) a pointer moving over a fixed dial with a scale, or a disk with a scale moving past a fixed reference mark, where each subdivision on the dial or disk is regarded as an increment of the test element. On the numbered scale of a test element the value of one complete revolution of the pointer shall be indicated in the form: "1 rev = …. <unit>". The beginning of the scale shall be indicated by the figure zero.

The scale spacing shall not be less than 1 mm and shall be constant throughout the whole scale.

The scale interval shall be in the form 1 x 10^n, 2 x 10^n, or 5 x 10^n <unit> (n being a positive or negative whole number or zero).

The scale marks shall be fine and uniformly drawn.

With an electronic indicating device the last digit is used as integral test element. The number of digits may be increased via a specific test mode, which can be accessed through either physical or electronic buttons or switches.

If applicable to the gas meter, the test element shall allow the experimental determination of the cyclic volume. The difference between the measured value of the cyclic volume and its nominal value shall not exceed 5 % of the latter at reference conditions.

6.2.3. Pulse generator

A pulse generator may be used as a test element if the value of one pulse, expressed in units of volume, mass or energy, is marked on the gas meter.
The gas meter shall be constructed in such a way that the pulse value can be checked experimentally. The difference between the measured value of the pulse value and the pulse value indicated on the gas meter, shall not exceed 0,05 % of the latter.

6.2.4. Portable test unit

An indicating device may include provisions for testing by inclusion of complementary elements (e.g. star wheels or discs), which provide signals for a portable test unit.

The portable test unit may be used as a test element if the value of one pulse, expressed in units of volume, mass or energy, is marked on the gas meter.

6.2.5. Increment of test element or pulse

The increment of the test element or pulse shall occur at least every 60 seconds at Q_{min}.

6.3. ANCILLARY DEVICES

6.3.1. General

The gas meter may include ancillary devices, which may be permanently incorporated or added temporarily. Examples are:

- Flow detection before this is clearly visible on the indicating device.
- Help for testing, verification and remote reading
- Prepayment

Ancillary devices shall not affect the correct operation of the instrument. If ancillary devices are not subject to legal metrology control this shall be clearly indicated.

6.3.2. Protection of drive shafts

When not connected to an attachable ancillary device, the exposed ends of the drive shaft shall be suitably protected.

6.3.3. Torque overload

The connection between the measuring transducer and the intermediate gearing shall not be broken or altered if a torque of three times the permissible torque as indicated in 4.2 (t) and 4.2 (u) is applied.

6.4. POWER SOURCES

6.4.1. Types of power sources

This Recommendation gives requirements for instruments powered by:

- mains power;
- non-replaceable battery;
- replaceable battery.

These three types of power sources may be used alone or in combination.

6.4.2. Mains power

An electronic gas meter shall be designed such that in the event of a mains power failure (AC or DC), the meter indication of the quantity of gas just before failure is not lost, and remains accessible for reading after failure without any difficulty.

Any other properties or parameters of the meter shall not be affected by an interruption of the electrical supply.

Note: Compliance with this clause will not necessarily ensure that the gas meter will continue to register the quantity of gas that passed the gas meter during a power failure.

The connection to the mains power source shall be capable of being secured from tampering.

6.4.3. Non-replaceable battery

The manufacturer shall ensure that the indicated lifetime of the battery guarantees that the meter functions correctly for at least as long as the operational lifetime of the meter.

6.4.4. Replaceable battery

Where the instrument is powered by a replaceable battery, the manufacturer shall give detailed specifications for the replacement of the battery.

The date by which the battery shall be replaced, shall be indicated on the meter. Alternatively, the remaining battery life can be displayed or a warning can be given when 10% of the estimated life of the battery is remaining.

The properties and parameters of the meter shall not be affected during replacement of the battery.

The battery must be able to be replaced without breaking the metrological seal.

The battery compartment shall be capable of being secured from tampering.

6.5. CHECKS, LIMITS AND ALARMS FOR ELECTRONIC GAS METERS

6.5.1. Checks

An electronic gas meter is required to

- detect the presence and correct functioning of transducers and devices;
- check the integrity of stored, transmitted and presented data;
- check the pulse transmission (if applicable).

Note: Pulse transmission checks focus on missing pulses, or additional pulses due to interference. Examples are double pulse systems, three-pulse systems or pulse timing systems.

6.5.2. Limits

The gas meter may also be capable to detect and act upon

- overload flow conditions;

- measurements results that are outside maximum and minimum values of transducers;
- measured quantities that are outside certain pre-programmed limits;
- reverse flow.

If the gas meter is equipped with limit detection the correct functioning shall be tested during the type evaluation.

6.5.3. Alarms

If malfunctions are registered while checking the items as indicated in 6.5.1 or if the conditions as indicated in 6.5.2 are detected, the following actions shall be performed:

- a visible or audible alarm, which remains present until the alarm is acknowledged and the cause of the alarm is suppressed;
- continuation of the registration in specific alarm registers (if applicable) during the alarm, in which case default values may be used for the pressure, temperature, compressibility, density or superior calorific value;
- a registration in a logger (if applicable).

7. Requirements for metrological controls

7.1. TEST RESULTS

When a test is conducted, the expanded uncertainty (k=2) of the determination of errors of the measured gas quantity shall meet the following specifications:

- for type evaluation: less than one-fifth of the applicable MPE
- for verifications: less than one-third of the applicable MPE

However, if the above-mentioned criteria cannot be met, the test results can be approved alternatively by reducing the applied maximum permissible errors with the excess of the uncertainties. In this case the following acceptance criteria shall be used:

- for type evaluation: $\pm\left(\frac{6}{5} \cdot MPE - U\right)$
- for verifications: $\pm\left(\frac{4}{3} \cdot MPE - U\right)$

The estimation of the expanded uncertainty U is made according to the *Guide to the expression of uncertainty in* measurement (1995 edition) [7] with a coverage factor k = 2.

*Example: A class 1 gas meter is tested during type evaluation with an uncertainty of 0,3% (k=2). In that case the test results can be accepted if the error is between ± (6/5*1,0 -0,3)% = ±0,9%.*

7.2. REFERENCE CONDITIONS

All influence quantities, except for the influence quantity being tested shall be held to the following values during type evaluation tests on a gas meter:

Working (gas/air) temperature:	(20,0 ± 5,0) ^{o}C;
Ambient temperature:	(20,0 ± 5,0) ^{o}C;
Ambient atmospheric pressure:	86 - 106 kPa;
Ambient relative humidity:	60% ± 15% for the tests mentioned in annex A;
Power voltage (AC/DC mains or battery)	nominal voltage (U_{nom});
Power frequency (AC mains)	nominal frequency (f_{nom}).

Note High-pressure tests may be performed at conditions other than reference conditions.

7.3. TYPE APPROVAL

7.3.1. General

Each type of a gas meter is subject to the type approval procedure.
Without special authorization, no modification may be made to an approved type.
The calculator (including indicating device) and the measuring transducer (including flow, volume, mass or energy sensor) of a gas meter, where they are separable and interchangeable with other calculators and measuring transducers of the same or different designs, may be the subject of separate type approvals.

7.3.2. Number of samples

The applicant shall deliver the requested number of sample gas meters, manufactured in conformity with the type, at the disposal of the authority responsible for type evaluation.
If so requested by the authority responsible for the type evaluation, these meters should include more than one size if simultaneous approval of a family of gas meters is requested.
Depending on the results of the tests, the authority responsible for the type evaluation may request further specimens.

7.3.3. Flowrates

The errors of the gas meters shall be determined at flowrates within 5% from the following specification:

$$Q_i = \left(\frac{Q_{\min}}{Q_{\max}}\right)^{\frac{i-1}{N-1}} Q_{\max}$$

in which i is the rank number of the test flowrate and N is the minimum number of test points according to

$$N = 1 + M \cdot \log\left(\frac{Q_{\max}}{Q_{\min}}\right)$$

rounded to the nearest integer. M is the number of test points per decade. For initial verifications $M \geq 3$ and $N \geq 6$.

Note: Here the same specification as used in OIML R 118 [8], is adopted. For a meter with a rangeability of 1:150, while using M=3 the number of test points is 1+3·log(150) = 7. The first formula leads now to 7 flowrates, distributed equally on a logarithmic flowrate scale. In any case the minimum of test points is 6.

7.3.4. Test gases

All tests as specified in Table 4 can be performed with air or any other gas as specified by the manufacturer under rated operating conditions stated in 5.1. For the temperature tests in section 7.4.7 it is important that the gas is dry.

However, the test with different gases as stated in 7.4.12 is performed with the rated gases, specified by the manufacturer.

7.3.5. Documentation

Applications for type approval for gas meters shall be accompanied by the following documents:

- a description of the meter giving the rated operating conditions (5.1), metrological and technical characteristics and the principle of its operation;
- a perspective drawing or photograph of the meter;
- a nomenclature of parts with a description of constituent materials of such parts;
- an assembly drawing with identification of the component parts listed in the nomenclature;
- a drawing showing the location of verification marks and seals;
- a drawing of the indicating device with adjustment mechanisms;
- a dimensioned drawing of metrologically important components;
- a drawing of the data plate or face plate and of the arrangements for inscriptions;
- where applicable: a drawing of any additional devices;
- where applicable: a table setting out the characteristics of the drive shafts;
- where applicable: a list of electronic components with their essential characteristics;
- where applicable: a description of the electronic devices with drawings, diagrams and general software explaining their construction and operation;
- where applicable: software version number;
- where applicable: the application for type approval shall be accompanied by any document or other evidence which supports the assertion that the design and construction of the gas meter comply with the requirements;
- a list of the documents submitted;
- a declaration specifying that the meter is manufactured in conformity with requirements for safety, particularly those concerning the maximum working pressure as indicated on the data plates.

7.3.6. Type approval certificate

The following information and data shall appear on the type approval certificate:

- the name and address of the company to whom the type approval certificate is issued,
- the type of the gas meter and/or commercial designation,
- the principal metrological and technical characteristics, such as Accuracy Class, unit(s) of measurement, values of Q_{max}, Q_{min} and Q_t, the rated operating conditions (5.1), the maximum working pressure, nominal internal diameter of the connecting pieces and, in the case of volumetric gas meters : the nominal value of the cyclic volume,
- the type approval sign,
- the period of validity of the type approval (if applicable),
- for meters equipped with drive shafts: the characteristics of the drive shafts,
- the environmental classification,
- information on the location of the marks and inscriptions required in section 4.2, initial verification marks and seals (where applicable, in the form of photographs or drawings),
- a list of the documents accompanying the type approval certificate,
- any special comments.

7.3.7. Directions for performing initial verification

The issuer of the type approval certificate may give specific directions for performing the initial verifications, different from section 7.5, which may be dependent on the technology of the meter and supported by test results of the type examination.

Note *Examples are the type of gas to be used, zeroing of coriolis meters or the use of specific flowrates.*

7.4. TYPE EVALUATION TESTS

In Table 4 the test program and appertaining requirements are summarized.

Table 4 — Test program and requirements *(Δe is defined in 2.2.10).*

No	Test	Clause	Minimum no. of samples	Requirement
1	Design inspection	7.4.1	all	
2	Checks and alarms	7.4.2	1	
3	Error	7.4.3	all	5.3 and 5.4
4	Reproducibility	7.4.4	1	experimental standard deviation ≤ 0,15 MPE
5	Orientation and flow direction	7.4.5	1	5.3 and 5.4
6	Working pressure	7.4.6	1	5.3 and $\Delta e \leq 0{,}5$ MPE
7	Temperature	7.4.7	1	5.3 ($t_{gas} = t_{ambient}$) double MPEs ($t_{gas} \neq t_{ambient}$)
8	Flow disturbance	7.4.8	1	$\Delta e \leq 0{,}33$ MPE during
9	Durability	7.4.9	Table 5	Double MPEs of 5.3 and • $\Delta e \leq$ MPE for class 1,5 • $\Delta e \leq 0{,}5$ MPE for other classes
10	Drive shaft test (torque)	7.4.10	1	$\Delta e \leq 0{,}33$ MPE at Q_{min}
11	Overload flow test	7.4.11	1	5.3 and $\Delta e \leq 0{,}33$ MPE after
12	Different gases	7.4.12	1	$\Delta e \leq 0{,}5$ MPE
13	Vibrations and shocks	7.4.13	1	$\Delta e \leq 0{,}5$ MPE after
14	Interchangeable	7.4.14	1	5.3 and $\Delta e \leq 0{,}33$ MPE

	components			
15	Electronics	7.4.15 + Annex A	1	Table 6
16	Software	7.4.16	1	5.3 and no detectable Δe

7.4.1. Design inspection

Each type of gas meter submitted shall be inspected externally to ensure that it complies with the provisions of the relevant preceding clauses of these requirements.

7.4.2. Checks and alarms

The correct functioning of checks and limits is examined as well as the handling of alarms, according to the requirements stated in 6.5.

7.4.3. Error

The error of the gas meter shall be determined, while using the flowrates according to the prescriptions stated in 7.3.3. The error curve as well as the WME (2.2.8) shall be within the requirements as specified in 5.3 and 5.4 respectively.
If a curve fit is made out of the observations a minimum of 6 degrees of freedom is required.

Note The number of degrees of freedom is the difference between the number of observations and the number of parameters or coefficients needed for the curve fit. For example, if a Straatsma polynomial is used with 4 coefficients, at least 10 measuring points are necessary in order to get a minimum of 6 degrees of freedom.

During the accuracy test applied on the gas meter, the following quantities shall be determined:

- the cyclic volume of the gas meter, if applicable, according to the provisions of 6.2.2, last sentence.
- the pulse factor of the gas meter, if applicable, according to the provisions of 6.2.3.
- the maximum pressure differential at Q_{max} and density of the gas, used for this test.

7.4.4. Reproducibility

At flowrates equal to or greater than Q_t the errors shall be determined independently at least six times, by varying the flowrate between each consecutive measurement. For each flowrate the experimental standard deviation of the six measurements shall be less than or equal to 0,15 times the maximum permissible error.

7.4.5. Orientation and flow direction

If the meter is marked as only operating in certain orientations, then the meter shall be tested in these orientations.

In the absence of such marks the meter shall be tested in at least three orientations: horizontal, vertical up and vertical down, unless the construction of the meter is orientation independent.
If the meter is able to measure the flowrate in two directions, the accuracy measurements as stated in 7.4.3 are performed in both directions.

7.4.6. Working pressure

The meter shall meet the requirements over the whole pressure range.
The error test shall be carried out at least the minimum and maximum operating pressure. However, for specified maximum pressures above 5 MPa (50 bar) a test at 5 MPa (50 bar) is deemed acceptable.
At each pressure the error shall be within the maximum permissible errors as stated in section 5.3.
The maximum mutual difference between the error curves, obtained at different pressures, is limited to 0,5 times the maximum permissible error.

7.4.7. Temperature

The temperature dependency of the gas meter shall be evaluated in the temperature range specified by the manufacturer, by one of the possibilities stated below, ranked in the following preferred order:

1. Flow tests at different temperatures (for mechanical and electronic meters)
   The flow tests are performed with a gas temperature equal to the ambient temperature as specified in 7.4.7.1 and with a gas temperature different from the ambient temperature as specified in 7.4.7.2.

2. Monitoring the unsuppressed flowrate output of the meter at no flow conditions at different temperatures (for electronic meters)

   At no flow conditions the unsuppressed flowrate output of the meter is used in order to determine the temperature influence on the meter accuracy. At each temperature the error shall be within the maximum permissible errors as stated in section 5.3, while taking into account the influence of the flowrate shift on the meter curve.

   Example: *The unsuppressed flowrate output of a class 1 gas meter is changed with +1 l/h due to temperature variations. The initial error at reference conditions of this meter was +0,3% at a Q_{min} of 200 l/h. The influence due to temperature variations at Q_{min} is 1/200*100% = +0,5%. The final value of +0,8% remains within the applicable maximum permissible errors.*

3. Evaluation of the construction of the meter

   Where the meter cannot be tested to determine the effect of temperature, the uncertainty resulting from the expected influence of temperature on the meter construction shall be evaluated.

7.4.7.1. Flow tests with equal gas and ambient temperatures

The flow tests are performed in the flow range Q_t up to Q_{max} while using the gas temperature equal to the ambient temperature, at

- Maximum ambient temperature
- Minimum ambient temperature
- Reference temperature

At each temperature the error shall be within the maximum permissible errors as stated in section 5.3.

7.4.7.2. Flow tests with unequal gas and ambient temperatures

The flow tests are performed while keeping the gas meter at laboratory temperature. The gas or air is heated such that the gas temperature at the meter inlet is 20 °C above the laboratory temperature. The error is determined at Q_t and Q_{max}.

The error shall be within the double maximum permissible errors as stated in section 5.3.

Note: *Instead of the above-mentioned temperature test some authorities may require the following test.*

The flow tests are performed at Q_t while using the following temperatures:

- *·Maximum ambient temperature and a gas temperature 30 °C below this ambient temperature;*
- *Minimum ambient temperature and a gas temperature 30 °C above this ambient temperature.*

The error shall be within the double maximum permissible errors as stated in section 5.3.

7.4.8. Flow disturbance test

Gas meters whose error is affected by the influence of flow disturbances shall be submitted to a test as specified in Annex B. During the test the meter shall be installed according manufacturer's specifications. The shift of the error curve shall not exceed 0,33 times the maximum permissible error.

7.4.9. Durability test

Gas meters with internal moving parts, shall undergo a durability test. This test consists of periods of continuous running, while using gases for which the meters are intended to be used. If the manufacturer demonstrates that the material of the gas meter is sufficiently insensitive to the gas composition, the authority responsible for the type examination may decide to perform the durability test with air or another suitable type of gas.

The durability test is the equivalent of 2000 hours at Q_{max} to be conducted within 120 days. Before and after the test the same reference equipment is used.

The authority responsible for the type examination shall choose the number of meters to be submitted to the durability test from the options given in Table 5 after discussion with the applicant. If different sizes are included, the total number of meters to be submitted shall be as stated in option 2.

Table 5 — Number of meters to be tested

Maximum equivalent volume flowrate [m^3/h]	Number of meters to be tested	
	Option 1	Option 2
$Q_{max} \leq 25$	3	6
$25 < Q_{max} \leq 100$	2	4
$Q_{max} > 100$	1	3

After the durability test the gas meters (with the exception of one of them if the durability test has been carried out on a number of gas meters according to option 2) shall comply with the following requirements:

- The error shall be within the double maximum permissible errors on initial verification as stated in section 5.3.
- The error shift due to the durability test shall not exceed the following values for the flowrates Q_t up to Q_{max}:
  * 1,0 times the applicable maximum permissible errors on initial verification for class 1,5;
  * 0,5 times the applicable maximum permissible errors on initial verification for other classes.

7.4.10. Gas meter with drive shafts

For types of gas meters with one or more drive shafts, the gas meter shall be tested with and without applying the maximum possible torque, while using a gas at a density of 1,2 kg/m^3. The error at Q_{min} shall not shift more than 0,33 times the maximum permissible errors due to the applied torque.

Where a type of gas meter includes various sizes, the torque test need only be carried out on the smallest size, provided that the same torque is specified for the larger gas meters and the drive shaft of the latter has the same or greater output constant.

7.4.11. Overload flow test

A gas meter with internal moving parts shall be able to withstand overload flow conditions of 1,2 Q_{max} for 1 hour and to continue to function within the maximum permissible errors after returning to rated operating conditions. The error values after the overload test shall not vary by more than 0,33 times the applicable maximum permissible errors from the initial corresponding values.

7.4.12. Different gases

The accuracy test as specified in 7.4.3 is performed with the rated gases, specified by the manufacturer, if:

- the error of the gas meter is expected to be dependent on the type of gas used, and
- verifications are intended to be performed with a fluid different from the one at operating conditions

Example *The verification is intended to be performed with air while the operating conditions are with natural gas.*

The maximum mutual difference between the error curves is limited to 0,5 times the maximum permissible error. The authority shall decide which gases are used during the investigation, depending on the application purpose of the gas meters under test.

7.4.13. Vibration and shocks

Gas meters with a maximum weight of 10 kg, as well as the electronics of other gas meters shall be able to withstand vibrations and shocks as specified in annex A (A.5.1 and A.5.2). The observed error shift shall not be more than 0,5 times the applicable maximum permissible error afterwards.

7.4.14. Interchangeable components

If a gas meter contains interchangeable components, e.g. ultrasonic transducers and meter cartridges, the influence of exchange shall be determined at Q_t. The test consists of the following accuracy tests:

- while using the starting configuration;
- after exchange of the component;
- after reinstalling the original component.

The maximum difference between any of the three accuracy tests shall not be more than 0,33 times the maximum permissible error in the upper range ($Q>Q_t$).

7.4.15. Electronics

If the gas meter includes electronic components, the tests as described in annex A of this Recommendation shall be performed. An overview of the test program is shown in Table 6, with the requirements pertaining for each test. After each test it shall be verified that no loss of data has occurred.

If the electronic devices of a gas meter are in a separate housing, their electronic functions may be tested independently of the measuring transducer of the gas meter by simulated signals representative of the rated operation of the meter, in which case the electronic devices shall be tested in their final housing.

In all cases, ancillary equipment may be tested separately.

The tests as indicated in Table 6 are performed under the following conditions:

- The meter under test is powered, except for the vibration and mechanical shock test;
- The dependency of the gas meter shall be evaluated by one of the flow possibilities stated below, ranked in the following preferred order:
  1. Flow tests, or
  2. Monitoring the unsuppressed flowrate output of the meter at no flow conditions.

  In case of monitoring the unsuppressed flowrate output of the meter the requirements indicated in Table 6 are checked while taking into account the influence of the flowrate shift on the meter curve.

  Note: Mostly, electronic meters have a cut-off for low flowrates. This cut-off must be switched off for this test so that the flowrate output is unsuppressed.

If applicable the tests of Table 6 may be combined with the tests as indicated in Table 4.

Table 6 — Test program for electronics (I refers to an influence test, D refers to a disturbance test)

No	Test	Clause	I/D	Minimum No. of samples	Requirement
A1	Dry heat	A.4.1.1	I	1	5.3
A2	Cold	A.4.1.2	I	1	5.3
A3	Damp heat, steady state (non-condensing)	A.4.2.1	I	1	5.3
A4	Damp heat, cyclic (condensing)	A.4.2.2	D	1	$\Delta e \leq$ 0,5 MPE after
A5	Vibration (random)	A.5.1	D	1	$\Delta e \leq$ 0,5 MPE after

No	Test	Clause	I/D	Minimum No. of samples	Requirement
A6	Mechanical shock	A.5.2	D	1	$\Delta e \leq$ 0,5 MPE after
A7	Radiated, radio-frequency, electromagnetic fields	A.6.1.1	I	1	5.3
A8	Conducted radio-frequency fields	A.6.1.2	I	1	5.3
A9	Electrostatic discharge	A.6.2	D	1	$\Delta e \leq$ 0,5 MPE after
A10	Bursts (transients) on signal, data and control lines	A.6.3	D	1	$\Delta e \leq$ 0,5 MPE during
A11	Surges on signal, data and control lines	A.6.4	D	1	$\Delta e \leq$ 0,5 MPE after
A12	DC mains voltage variation	A.7.1	I	1	5.3
A13	AC mains voltage variation	A.7.2	I	1	5.3
A14	AC mains voltage dips, short interruptions and voltage variations	A.7.3	D	1	$\Delta e \leq$ 0,5 MPE after
A15	Bursts (transients) on AC and DC mains	A.7.4	D	1	$\Delta e \leq$ 0,5 MPE during
A16	Surges (transients) on AC and DC mains lines	A.7.5	D	1	$\Delta e \leq$ 0,5 MPE after
A17	Power supply from internal battery (not connected to mains power)	A.8	I	1	5.3

7.4.16. Software

If the gas meter is provided with software, it shall be tested to ensure that no metrological or legal parameters can be changed, having regard to the precautions as described in 4.3.4. for electronic sealing devices.

Communication with the gas meter may not cause any influence on the accuracy of the measurements.

7.5. INITIAL VERIFICATION AND SUBSEQUENT VERIFICATION

7.5.1. General

Initial verification and subsequent verification shall be carried out either individually or statistically, as described in section 7.6. In all cases the meters shall conform to the requirements of this recommendation. The following minimum program shall be carried out for both the individual and statistical verification.

7.5.2. Conformity with the approved type

Gas meters shall be examined to ascertain whether they conform to their approved type.

7.5.3. Submission

Gas meters shall be submitted to initial verification in working order and shall be provided with the required sites for the application of the verification and protection marks.

7.5.4. Output shafts

If gas meters are intended to incorporate ancillary devices operated by the output shafts, these devices shall be attached, unless attachment after verification is explicitly authorized.

7.5.5. Test conditions

The accuracy requirements of chapter 5 shall be verified while using the conditions of the gas which are as close as possible to the operating conditions (pressure, temperature, gas type) under which the meter will be put into service.

The verification may also be performed with a type of gas (e.g. air) other than the meter is intended to be used with, if the authorities responsible for the verification are convinced by either the outcome of the tests with different gases as described in 7.4.12 or the technical construction of the meter under test, that comparable results will be gained.

7.5.6. Flow rates

The gas meter is tested at the flowrates as specified in 7.3.3.

If supported by the directions for performing verifications (see 7.3.7) authorities may perform the initial verification at a reduced number of flow rates or at flowrates differing from the ones prescribed in 7.3.3.

Notes: 1. *For the diaphragm meter verification may be performed at Q_{max}, $0{,}2 \cdot Q_{max}$ and Q_{min}.*

2. *Countries may also decide to use a reduced number of test points for rotary piston gas meters.*

7.5.7. Orientation and flow direction

If during type approval evaluation the meter performance appeared to be dependent on flow direction and/or meter orientation (see section 7.4.5), the verification shall be performed in both flow directions and/or the meter orientations specified by the manufacturer.

7.5.8. Adjustments

If the error curve or the WME (2.2.8) is outside the requirements as specified in 5.3 and 5.4 respectively, the gas meter shall be adjusted such that the WME is as close to zero as the adjustment and the maximum permissible errors allow.

Notes: *After changing the adjustment while using single point adjustment it is not necessary to repeat all tests. It is sufficient to repeat a test at one flowrate and calculate the other error values from the previous ones.*
For high-pressure applications adjustment is performed while taking into account the operating conditions.

7.6. ADDITIONAL REQUIREMENTS FOR STATISTICAL VERIFICATIONS

7.6.1. General

This chapter contains the requirements additional to section 7.5, for initial verification on statistical basis.

Note: *National authorities can decide whether the use of statistical methods is allowed.*

7.6.2. Lot

A lot shall consist of 1000 meters maximum, with homogeneous characteristics. In particular, the type approval identification, meter type, meter range and year of manufacturing shall be identical.

7.6.3. Samples

Samples shall be randomly taken from a lot.

Note: *The number of samples can be chosen freely taking into account requirement 7.6.4. From the table at the end of 7.6.4 it follows that the minimum number of samples is 40.*

7.6.4. Statistical testing

The statistical procedure shall meet the following requirements:

The statistical control will be based on attributes. The sampling system shall ensure

- an Acceptance Quality Level (AQL) of not more than 1 % and
- a Limiting Quality (LQ) of not more than 7 %.

The AQL is the maximum percentage of non-conform items in a lot at which the lot has a probability of 95 % to be accepted.

The LQ is the percentage of non-conform items in a lot at which the lot has a maximum probability of 5 % to be accepted.

Note: *This requirement gives the testing laboratory a substantial freedom in organising the test. Examples are given in the table below. If 70 meters are tested and 1 meter appears to be non-conforming on one of the attributes, the lot passes.*

Number of instruments to be tested	40	70	100	1000
Maximum number of non-conforming instruments	0	1	2	10

7.7. ADDITIONAL REQUIREMENTS FOR IN-SERVICE INSPECTIONS

See OIML guidance document for in-service inspections (now being drafted by TC3 SC4) [10].

Annex A: Environmental influence tests for electronic instruments or devices

(Mandatory)

Based on:
OIML Document D 11 [6]

A.1 General

This Annex defines the program of performance tests intended to verify that electronic gas meters and their ancillary devices may perform and function as intended in a specified environment and under specified conditions. Each test indicates, where appropriate, the reference conditions for determining the error.

These tests supplement any other prescribed test.
When the effect of one influence quantity is being evaluated, all other influence quantities are to be held within the limits of the reference conditions.

A.2 Severity levels

For each performance test, typical test conditions are indicated. They correspond to the climatic and mechanical environment conditions to which instruments are usually exposed.

The metrology service carries out performance tests at severity levels corresponding to these environmental conditions. If type approval is granted, the documentation supplied by the manufacturer or his representative to the client or user shall indicate the corresponding limits of use. Manufacturers shall inform potential clients or users of the conditions of use for which the instrument is approved. The metrology service shall verify that the conditions of use are met.

A.3 Reference conditions

See 7.2.

A.4 Performance tests (climatic)

A.4.1 Static temperatures

A.4.1.1 Dry heat (non condensing): influence test					
Applicable standards	IEC 60068-2-2 [15]				
Test procedure in brief	The test consists of exposure to the specified high temperature under "free air" conditions for the time specified (the time specified is the time after the EUT has reached temperature stability). The change of temperature shall not exceed 1 °C/min during heating up and cooling down. The absolute humidity of the test atmosphere shall not exceed 20 g/m^3. When testing is performed at temperatures lower than 35 °C, the relative humidity shall not exceed 50 %.				
Severity levels	1	2	3	4	unit
Temperature	30	40	55	70	°C
Duration	2	2	2	2	h

A.4.1.2 Cold: influence test					
Applicable standards	IEC 60068-2-1 [14]				
Test procedure in brief	The test consists of exposure to the specified low temperature under "free air" conditions for the time specified (the time specified is the time after the EUT has reached temperature stability). The change of temperature shall not exceed 1 °C/min during heating up and cooling down. IEC specifies that the power to the EUT shall be switched off before the temperature is raised.				
Severity levels	1	2	3	4	unit
Temperature	5	-10	-25	-40	°C
Duration	2	2	2	2	h

A.4.2 Damp heat

A.4.2.1 Damp heat, steady-state (non condensing): influence test			
Applicable standards	IEC 60068-2-78 [20]		
Test procedure in brief	The test consists of exposure to the specified temperature and the specified constant relative humidity for a certain fixed time defined by the severity level. The EUT shall be handled such that no condensation of water occurs on it. The gas meter shall be subjected 3 times to an accuracy test: - at reference conditions, before the increase of temperature; - at the end of the upper temperature phase; - at reference conditions, 24 h after the decrease of temperature.		
Severity levels	1 (*)	2	unit
Temperature	30	40	°C
Humidity	85	93	% rel.
Duration	2	4	days
Note	(*) Only applicable if the rated upper temperature is 30 °C. In all other cases, severity level 2 is applicable		

A.4.2.2 **Damp heat, cyclic (condensing)**: disturbance test			
Applicable standards	IEC 60068-2-30 [16]		
Test procedure in brief	The test consists of exposure to cyclic temperature variation between 25 °C and the appropriate upper temperature, maintaining the relative humidity above 95 % during the temperature change and low temperature phases, and at 93 % at the upper temperature phases. Condensation should occur on the EUT during the temperature rise. The 24 h cycle consists of: 1) temperature rise during 3 h 2) temperature maintained at upper value until 12 h from the start of the cycle 3) temperature lowered to lower value within 3 h to 6 h, the rate of fall during the first hour and a half being such that the lower value would be reached in 3 h 4) temperature maintained at lower value until the 24 h cycle is completed. The stabilizing period before and recovery after the cyclic exposure shall be such that all parts of the EUT are within 3 °C of their final temperature. During the test the instrument is under power; no gas flow is necessary. After the last cycle, the recovery time shall be at least 4 h.		
Severity levels	1 (1)	2 (2)	unit
Upper temperature:	40	55	°C
Duration	2	2	cycles
Notes	(1) Applicable if the rated upper temperature is 30 °C or 40 °C. (2) Applicable if the rated upper temperature is 55 °C or 70 °C.		

A.5 Performance tests (mechanical)

A.5.1 **Vibration (random)**: disturbance test	
Applicable standard	IEC 60068-2-47 [18], IEC 60068-2-64 [19]
Test procedure in brief	The test consists of exposure to the vibration level for a time sufficient for testing the various functions of the EUT during the exposure. The EUT shall, in turn, be tested in three, mutually perpendicular axes mounted on a rigid fixture by its normal mounting means. The EUT shall normally be mounted so that the gravitational force acts in the same direction as it would in normal use. Where the effect of gravitational force is not important the EUT may be mounted in any position. Example: a diaphragm gas meter has to be tested always in an upright position, for each direction in which the meter has to be tested.
Total frequency range	10 - 150 Hz
Total RMS level	7 $m \cdot s^{-2}$
ASD level 10-20 Hz	1 $m^2 \cdot s^{-3}$
ASD level 20-150 Hz	-3 dB/octave
Number of axes	3
Duration per axis	2 minutes

A.5.2 Mechanical shock: disturbance test	
Applicable standard	IEC 60068-2-31 [17]
Test procedure in brief	The EUT, placed in its normal position of use on a rigid surface, is tilted towards one bottom edge and is then allowed to fall freely on to the test surface. The height of fall is the distance between the opposite edge and the test surface. However, the angle made by the bottom and the test surface shall not exceed 30°.
Height of fall	50 mm
Number of falls (on each bottom edge)	1

A.6 Performance tests (electrical, general)

A.6.1 Radio frequency immunity tests

A.6.1.1 Radiated, radio frequency, electromagnetic fields: influence test	
Applicable standard	IEC 61000-4-3 [24]
Test procedure in brief	The EUT shall be exposed to electromagnetic field strength as specified by the severity level and a field uniformity as defined by the referred standard. The EM field can be generated in different facilities, however the use of which is limited by the dimensions of the EUT and the frequency range of the facility. The frequency ranges to be considered are stepped incrementally with the modulated signal, pausing to adjust the RF signal level or to switch oscillators and antennas as necessary. The step size shall not exceed 1 % of the preceding frequency value. The dwell time of the amplitude modulated carrier at each frequency shall not be less than the time necessary for the EUT to be exercised and to respond, but shall in no case be less than 0,5 s. The sensitive frequencies (e.g. clock frequencies) shall be analyzed separately. (1)
Frequency range	80 MHz - 2 GHz (2), (4) 26 MHz - 2 GHz (3)
Field strength	10 V/m
Modulation	80 % AM, 1 kHz, sine wave
Notes	(1) Usually, these sensitive frequencies can be expected to be the frequencies emitted by the EUT. (2) IEC 61000-4-3 (1995-03) [24] only specifies test levels above 80 MHz. For frequencies in the lower range the test methods for conducted radio frequency disturbances are recommended (test A.6.1.2). (3) However, for EUT having no mains or other input port available the lower limit of the radiation test should be 26 MHz taking into account that the test specified in A.6.1.2 cannot be applied (refer to Annex H of IEC 61000-4-3 [24]). In all other cases both A.6.1.1 and A.6.1.2 shall apply. (4) For the frequency range 26 - 80 MHz, the testing laboratory can either carry out the test according to A.6.1.1 or according to A.6.1.2. But in case of a dispute, the results according to A.6.1.2 shall prevail.

A.6.1.2 Conducted radio-frequency fields: influence test	
Applicable standard	IEC 61000-4-6 [27]
Test procedure in brief	Radio frequency EM current, simulating the influence of EM fields shall be coupled or injected into the power ports and I/O ports of the EUT using coupling/decoupling devices as defined in the referred standard. The performance of the test equipment consisting of an RF generator, (de-)coupling devices, attenuators, etc. shall be verified.
RF amplitude (50 Ω)	10 V (e.m.f.)
Frequency range	0,15 - 80 MHz
Modulation	80 % AM, 1 kHz sine wave
Notes:	(1) This test is not applicable when the EUT has no mains or other input port (2) If the EUT is composed of several elements, the tests shall be performed at each extremity of the cable if both of the elements are part of the EUT. (3) For the frequency range 26 - 80 MHz, the testing laboratory can either carry out the test according to A.6.1.1 or according toA.6.1.2. But in case of a dispute, the results according to A.6.1.2 shall prevail.

A.6.2 Electrostatic discharge: disturbance test		
Applicable standard	IEC 61000-4-2 [23]	
Test procedure in brief	An ESD generator shall be used with a performance as defined in the referred standard. Before starting the tests, the performance of the generator shall be verified. At least 10 discharges shall be applied. The time interval between successive discharges shall be at least 10 seconds. For EUT not equipped with a ground terminal, the EUT shall be fully discharged between discharges. Contact discharge is the preferred test method. Air discharges shall be used where contact discharge cannot be applied. Direct application: In the contact discharge mode to be carried out on conductive surfaces, the electrode shall be in contact with the EUT. In the air discharge mode on insulated surfaces, the electrode is approached to the EUT and the discharge occurs by spark. Indirect application: The discharges are applied in the contact mode to coupling planes mounted in the vicinity of the EUT.	
Test voltage	Contact discharge (1)	6 kV
	Air discharge (1)	8 kV
Notes:	(1) Contact discharges shall be applied on conductive surfaces. Air discharges shall be applied on non-conductive surfaces.	

A.6.3 **Bursts (transients) on signal, data and control lines**: disturbance test		
Applicable standards	IEC 61000-4-4 [25]	
Test procedure in brief	A burst generator shall be used with the performance characteristics as specified in the referred standard. The test consist of exposure to bursts of voltage spikes for which the repetition frequency of the impulses and peak values of the output voltage on 50 Ω and 1000 Ω load are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 min for each amplitude and polarity. For the coupling of the bursts into the I/O and communication lines, a capacitive coupling clamp as defined in the standard shall be used. For integrating instruments, the test pulses shall be continuously applied during the measuring time.	
Test voltage	Amplitude (peak value)	1 kV
	Repetition rate	5 kHz

A.6.4 Surges on signal, data and control lines: disturbance test			
Applicable standard:	IEC 61000-4-5 [26]		
Test procedure in brief	A surge generator shall be used with the performance characteristics as specified in the referred standard. The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. At least 3 positive and 3 negative surges shall be applied. The injection network depends on the lines the surge is coupled into and is defined in the referred standard. The test pulses shall be continuously applied during the measuring time.		
Test voltage	Unbalanced lines	Line to line: 1.0 kV	Line to earth: 2.0 kV [1]
	Balanced lines	Line to line: NA	Line to earth: 2.0 kV [1]
Notes	[1] Normally tested with primary protection		

A.7 Performance tests (electrical, mains power)

A.7.1 **DC mains voltage variation**: influence test	
Applicable standard	IEC 60654-2 [21]
Test procedure in brief	The test consists of exposure to the specified power supply condition for a period sufficient for establishing stability.
Test severity	The upper limit will be the DC level at which the electronic instrument has been manufactured to automatically detect high-level conditions. The lower limit will be the DC level at which the electronic instrument has been manufactured to automatically detect low-level conditions. The instrument shall comply with the specified maximum permissible errors at supply voltage levels between the two levels.

A.7.2 AC mains voltage variation: influence test		
Applicable standards	IEC/TR3 61000-2-1 [22]	
Test procedure in brief	The test consists of exposure to the specified power condition for a period sufficient for achieving temperature stability and for performing the required measurements.	
Mains voltage (1), (2)	upper limit	U_{nom} + 10 %
	lower limit	U_{nom} - 15 %
Notes:	(1) In the case of three-phase power supply, the voltage variation shall apply for each phase successively. (2) The values of *U* are those marked on the measuring instrument. In case a range is specified, the "-" relates to the lowest value and the "+" to the highest value of the range.	

A.7.3 AC mains voltage dips, short interruptions and voltage variations: disturbance test					
Applicable standards	IEC 61000-4-11 [28], IEC 61000-6-1 [29], IEC 61000-6-2 [30]				
Test procedure in brief	A test generator suitable to reduce for a defined period of time the amplitude of the AC mains voltage is used. The performance of the test generator shall be verified before connecting the EUT. The mains voltage reductions shall be repeated 10 times with an interval of at least 10 seconds. The test pulses shall be continuously applied during the measuring time.				
Test (1, 2)		test a	test b	test c	unit
Voltage reduction	Reduction	30	60	60	%
	Duration	0,5	5	50	cycles
Voltage interruption	Interruption	> 95			%
	Duration	250			cycles
Notes:	(1) This is an interpretation of IEC 61000-4-11 [28] and according to IEC 61000-6-1 [29] and IEC 61000-6-2 [30]. (2) All 3 tests (a, b and c) are applicable; it is possible that any of the tests fail while the other tests pass.				

A.7.4 Bursts (transients) on AC and DC mains: disturbance test	
Applicable standards	IEC 61000-4-4 [25]
Test procedure in brief	A burst generator shall be used with the performance characteristics as specified in the referred standard. The test consist of exposure to bursts of voltage spikes for which the repetition frequency of the impulses and peak values of the output voltage on 50 Ω and 1000 Ω load are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. Both positive and negative polarity of the bursts shall be applied. The duration of the test shall not be less than 1 min for each amplitude and polarity. The injection network on the mains shall contain blocking filters to prevent the burst energy being dissipated in the mains.
Amplitude	peak value: 2 kV
Repetition rate	5 kHz

A.7.5 Surges on AC and DC mains lines: disturbance test		
Applicable standard:	IEC 61000-4-5 [26]	
Test procedure in brief	A surge generator shall be used with the performance characteristics as specified in the referred standard. The test consists of exposure to surges for which the rise time, pulse width, peak values of the output voltage/current on high/low impedance load and minimum time interval between two successive pulses are defined in the referred standard. The characteristics of the generator shall be verified before connecting the EUT. On AC mains supply lines at least 3 positive and 3 negative surges shall be applied synchronously with AC supply voltage in angles 0°, 90°, 180° and 270°. On DC power lines, at least 3 positive and 3 negative surges shall be applied. The injection network depends on the lines the surge is coupled into and is defined in the referred standard. The test pulses shall be continuously applied during the measuring time.	
Test voltage	Line to line: 1.0 kV	Line to earth: 2.0 kV

A.8 Performance test (battery powered instrument)

A.8 Low voltage of internal battery (not connected to the mains power): influence test	
Applicable standards	There is no reference to standards for this test.
Test procedure	The test consists of exposure to the specified condition of the battery(s) for a period sufficient for achieving temperature stability and for performing the required measurements. If an alternative power source (standard power supply with sufficient current capacity) is used in bench testing to simulate the battery, it is important that the internal impedance of the specified type of battery also be simulated. The maximum internal impedance of the battery is to be specified by the manufacturer of the instrument.
Lower limit of the voltage	The lowest voltage at which the instrument functions properly according to the specifications
Number of cycles	At least one test cycle for each functional mode

Annex B: Flow disturbance tests

B.1. General

B.1.1. The test specified in this Annex should be carried out with air at atmospheric pressure, at flowrates of 0,25 Q_{max}, 0,4 Q_{max} and Q_{max}. Alternatively, the test is performed with natural gas at p_{min} in case this value is higher than the atmospheric pressure.

B.1.2. If the design of the type of the gas meter is similar for all pipe sizes, it is sufficient to perform the test on two sizes.

B.2. Mild flow disturbances

B.2.1. The piping configurations (see figure 1a and 1b) consist of a pipe with a nominal diameter DN_1, and with a length of 5 DN_1, two elbows with radius DN_1, not in the same plane, and a concentric expander with diameter DN_1 and DN and a length between DN and 1,5 DN.

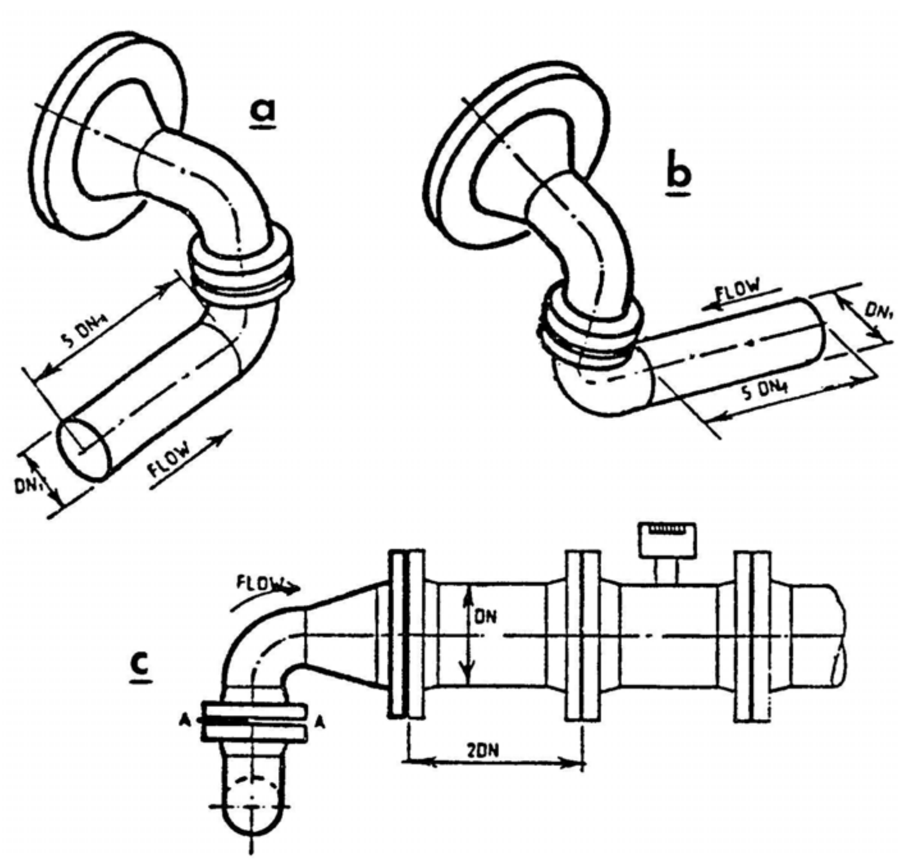

Figure 1: Piping configurations for mild flow disturbances

The values of DN_1, in relation to the values of DN are listed in the following Table:

DN (meter) (mm)	**DN_1 (pipe) (mm)**
50	40
80	50
100	80
150	100
200	150
250	200
300	250
400	300
500	400
600	500
750	600
1000	750

For smaller or bigger sizes decimal multiples are used of the values stated in the table.

B.2.2. The test shall be carried out with the piping configurations as described in point B.2.1 installed 2 DN upstream of the meter inlet (see figure 1c), or with a longer upstream straight pipe and/or flow conditioner if so specified by the manufacturer.
In the latter case the necessary upstream straight pipe and/or flow conditioner shall be considered part of the approved type and specified in the approval certificate.

B.2.3. During the test the shift of the error curve of the meter shall not exceed 0,33 times the maximum permissible error.

B.3. Severe flow disturbances

B.3.1. The same piping configuration as specified in B.2.1 is used with the addition of a half pipe area plate as shown in figure 2 installed between the two elbows with the opening toward the outside radius of the first bend.

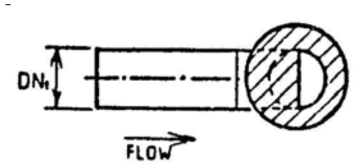

Figure 2: Half pipe area plate for severe flow disturbances

B.3.2. The provisions of points B.2.2 and B.2.3 apply accordingly.

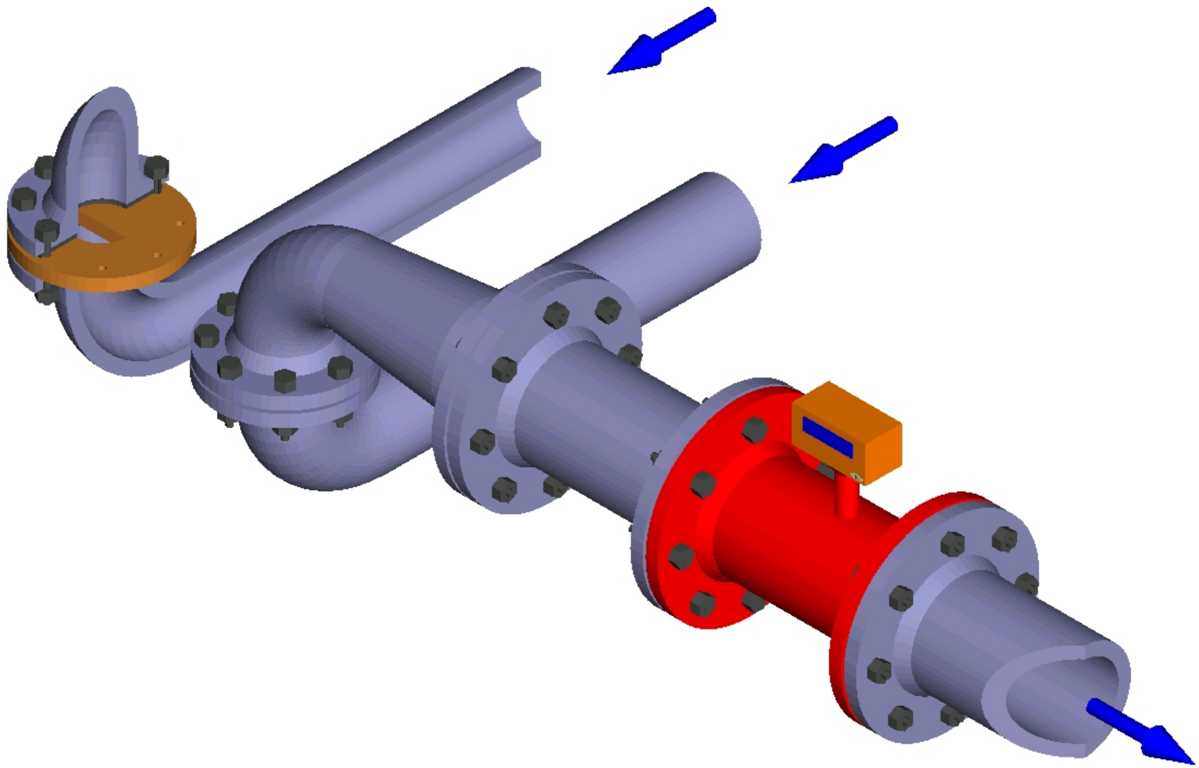

Figure 3: Three-dimensional representation of figures 1 and 2.

Annex C: Overview of tests applicable for different metering principles

(Informative)

C.1 General

This Annex shows the tests required for the different metering principles. In the table below the diaphragm gas meter, the Temperature Compensated (TC) diaphragm gas meter, the rotary piston gas meter and the turbine gas meter are purely mechanical meters.
If electronics and/or software are added to these mechanical operating principles, the electronic and software tests will apply as well.

Table C.1 Overview of applicable tests for different metering principles

Test	Clause	Diaphragm	TC diaphragm	Rotary piston	Turbine	Ultrasonic	Coriolis	Thermal mass	Vortex
Design inspection	7.4.1	X	X	X	X	X	X	X	X
Alarms and limits	7.4.2	-	-	-	-	X	X	X	X
Error	7.4.3	X	X	X	X	X	X	X	X
Reproducibility	7.4.4	X	X	X	X	X	X	X	X
Orientation and flow direction	7.4.5	-	-	X	X	if applicable	X	-	-
Working pressure	7.4.6	X	X	X	X	X	X	X	X
Temperature	7.4.7	X	X	X	X	X	X	X	X
Flow disturbance	7.4.8	-	-	-	X	X	-	-	X
Durability	7.4.9	X	X	X	X	-	-	-	-
Drive shaft test (torque)	7.4.10	-	-	if applicable	if applicable	-	-	-	-
Overload flow test	7.4.11	X	X	X	X	-	-	-	-
Different gases	7.4.12	X	X	X	X	X	X	X	X
Vibrations and shocks	7.4.13	X	X	X	X	X	X	X	X
Interchangeable components	7.4.14	-	-	if applicable	if applicable	if applicable	-	-	-
Electronics	7.4.15 + Annex A	-	-	-	-	X	X	X	X
Software	7.4.16	-	-	-	-	X	X	X	X

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